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ANADROMOUS FISH STUDIES

ANADROMOUS FISH STUDIES

AFS-44-9 David C. Nelson

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TABLE OF CONTENTS

PROJECT NO. AFS-44 ANADROMOUS FISH STUDIES Page

Segment No. AFS-44-9 Russian River Sockeye Salmon Study
By: David C. Nelson

LIST OF TABLES AND FIGURES

TABLE OF CONTENTS (Cont'd.)

Volume 24 Project AFS-44

STATE OF ALASKA

Bill Sheffield, Governor

Annual Performance Report for

RUSSIAN RIVER SOCKEYE SALMON STUDY

by

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ALASKA DEPARTMENT OF FISH AND GAME
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Volume 24 Project AFS-44-9-"S"*

RESEARCH PROJECT SEGMENT

State: ALASKA Name: Sport Fish Investigations of Alaska

Project No.: AFS-44 Project Title: ANADROMOUS FISH STUDIES

Segment No.: AFS-44-9 Segment Title: Russian River Sockeye Salmon Study

Cooperator: David C. Nelson

Period Covered: July 1, 1982 to June 30, 1983

ABSTRACT

A creel census was conducted during the 1982 Russian River sockeye salmon, Oncorhynchus nerka (Walbaum), sport fishery to determine harvest and angler participation. Census data revealed 51,480 man-days of angler effort were expended to harvest 44,820 sockeye salmon. Early and late runs contributed 34,500 and 10,320 salmon, respectively, to the harvest. Sport fishermen caught 34.1 percent of the sockeye salmon population which returned to the upper Russian River drainage in 1982. Seasonal catch per angler hour was 0.20.

The incidental harvest of coho salmon, Oncorhynchus kisutch (Walbaum), pink salmon, Oncorhynchus gorbuscha (Walbaum), Dolly Varden, Salvelinus malma (Walbaum), rainbow trout, Salmo gairdneri Richardson, and Arctic grayling, Thymallus arcticus (Pallas), in Russian River as determined by the Statewide Harvest Survey are presented and discussed.

Spawning escapements of early and late run sockeye salmon were determined by weir at the outlet of Lower Russian Lake. Early and late run spawning escapements to the upper Russian Lake drainage were 56,080 and 30,360 salmon, respectively. Early run escapement was the highest recorded and exceeded the minimum escapement goal of 9,000 fish by 523.1 percent. Late run escapement was one of the lowest recorded. An additional 45,000 late run sockeye salmon spawned below Russian River Falls. This is the highest spawning escapement recorded in this area. Total late run escapement to upper and lower Russian River drainage was, therefore, 75,630 sockeye salmon.

Management of the 1982 recreational fishery is discussed as is the status of the stocks during the last cycle as compared to historic data. A comparison of these two periods reveals combined early and late run returns have increased 90.3 percent during the last cycle and numbers of salmon in the spawning escapement by 63.8 percent during the same period.

*"S" = 100% State funding.

Analysis of scales collected at lower Russian Lake weir indicated 98.4 percent of the early run was comprised of 6-year fish of age class 2.3. Age class 1.3 and 2.2 contributed 1.2 and 0.4 percent, respectively. This age structure conforms to the historical age class composition, in that age class 2.3 is the prevalent age class. Mean length of early run salmon was 589.5 millimeters (23.3 inches). Male to female sex ratio was 1:1.0. Forty-six percent of the late run were 5-year fish of age class 2.2. Other age classes represented were 2.3 (39.2 percent), 1.2 (8.8 percent), 3.2 (2.0 percent) and 3.3 (1.2 percent). These data approximate the historic age class composition of this run. Mean length of the late run fish was 559.7 millimeters (22.0 inches). Male to female sex ratio was 1:1.3.

Fecundity of early and late run sockeye salmon averaged 3,479 and 3,702 eggs per female, respectively. Early and late run fish averaged 5.9 and 6.0 eggs per millimeter of body length and 1,318 and 1,361 eggs per kilogram of body weight, respectively. Mean length of early run fish sampled approximated lengths of these fish in prior years. Late run fish sampled were the largest (both length and weight) sampled since fecundity investigations were begun in 1973. This is the first year fecundity of late run fish exceeded the fecundity of early run salmon.

Water velocities through Russian River Falls were moderate during the 1982 sockeye salmon migration. Use of the fish pass was not required.

Egg sampling to determine early run egg deposition in upper Russian Creek was not conducted in 1982. Data indicate there is no correlation between egg deposition and the numbers of returning adult early run fish.

Climatological data were collected at Lower Russian Lake weir. Air and water temperatures approximated historical data. Flow rates approximated mean Russian River discharge as determined by U.S. Geological Survey from 1947-1954.

KEY WORDS

Alaska, Russian River, sockeye salmon, harvest, fishing, intensity, spawning escapement, production, egg deposition, age structure, fecundity.

BACKGROUND

Russian River is a clear stream adjacent to the Sterling Highway 9.6 km (6 mi) west of the Kenai Peninsula community of Cooper Landing, and approximately 160 km (100 mi) south of Alaska's largest city, Anchorage. The stream bisects Federally managed lands. To the south, land is administered by the Kenai National Wildlife Refuge and to the north by the Chugach National Forest. A privately operated ferry at the Kenai and Russian River confluence transports anglers to the south bank. In an average year, this area (approximately 1.6 km or 1 mi) receives 50% of all angler effort as fishermen attempt to intercept the runs prior to their entry into Russian River. The remaining effort occurs on approximately 3.2 km (2 mi) of Russian River above the confluence of the Kenai and Russian Rivers and at the Chugach National Forest Campground adjacent to Russian River. Figure 1

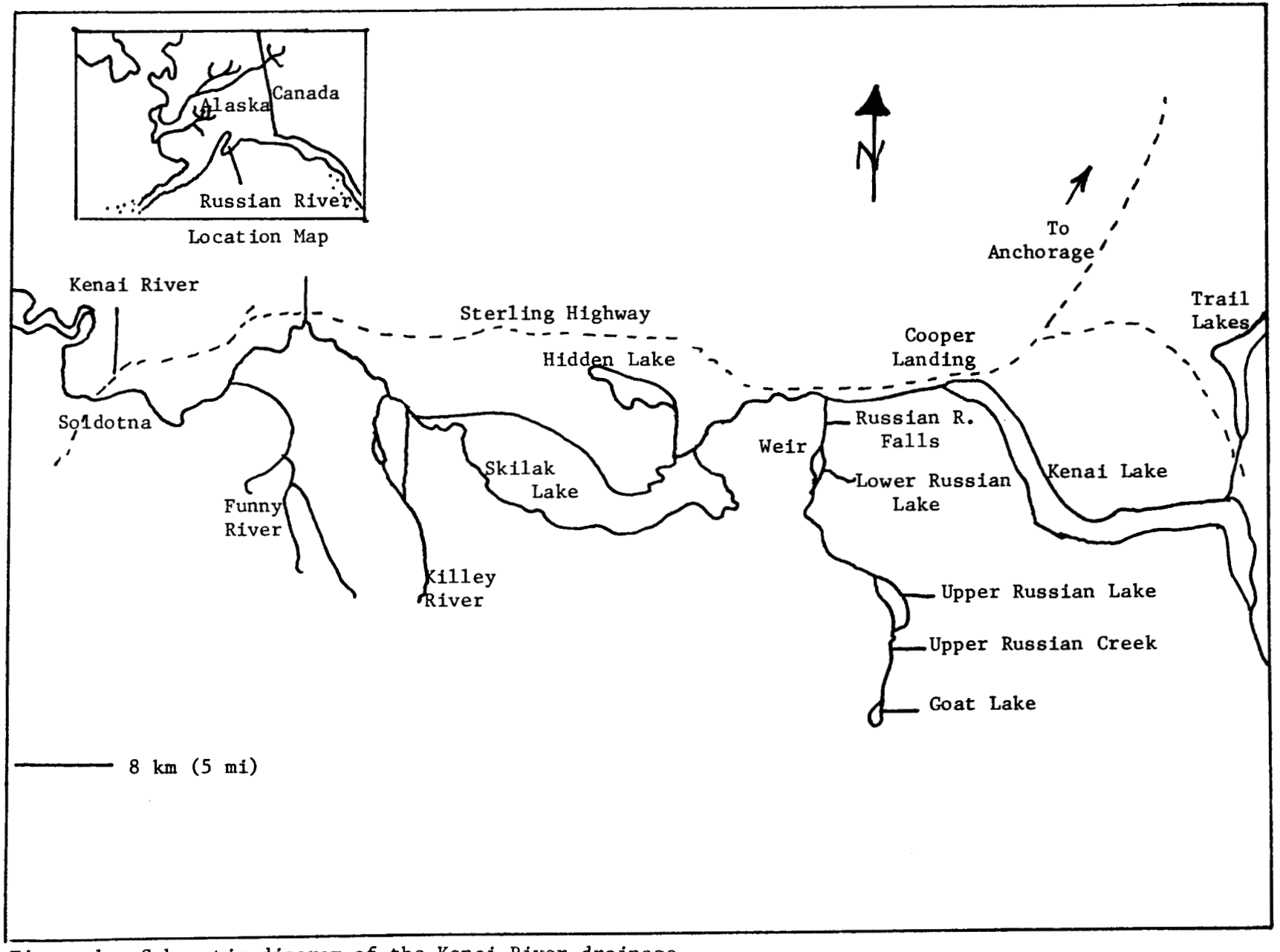

Figure 1. Schematic diagram of the Kenai River drainage.

depicts the general location of Russian River and other pertinent landmarks.

Sockeye salmon sport fishing occurs from a marker 548 m (600 yds) below Russian River Falls to a marker 1,646 m (1,800 yds) below the confluence of Kenai and Russian Rivers, a distance of approximately 4.8 km (3 mi). This area is commonly known as the "fly-fishing-only area" and, from June 1 through August 20, terminal gear is restricted to coho (streamer) flies with gap between point and shank no greater than 9.5 mm (3/8 in). The area between a marker below the ferry crossing and a marker 640 m (700 yds) upstream on Russian River is closed to all fishing from June 1 through July 14 to provide additional protection to early-run sockeye salmon which concentrate in this area prior to continuing their upstream migration (Figure 2). Sockeye salmon sport fishing does occur in the Kenai River below the "fly-fishing-only area" with conventional tackle. Harvest and effort here is minimal due to the glacial nature of the Kenai River.

Lower Russian River from its confluence with the Kenai River upstream for approximately 3.2 km (2 mi) is of moderate gradient. Above this point the stream flows through a canyon of considerable gradient known as Russian River Falls. Sockeye salmon have been delayed and/or totally blocked by this canyon on several occasions due to a velocity barrier caused by atypically high water. Documented mortalities of both early and late run sockeye salmon were associated with this barrier in 1971 and 1977 (Nelson, 1978). In 1979, a fish pass was constructed around the falls to enable salmon to negotiate this segment of Russian River at all water levels.

Russian River sockeye salmon runs are bimodal; i.e., there are two distinct runs. Early and late runs have averaged 24,480 and 56,670 fish, respectively, from 1963 through 1981. Migrational timing and entry into the fishery for these stocks have been previously presented (Nelson, 1976-1977). Resident and anadromous fish species present in Russian River are presented in Table 1.

Lower Russian Lake, 0.8 km (0.5 mi) above Russian River Falls, supports a Dolly Varden and rainbow trout fishery. Physical characteristics of the lake have been described (Nelson, 1979). Sockeye salmon spawning in this lake is limited to less than 500 late-run fish. Observation indicates this lake is utilized by rearing chinook and coho salmon. These species spawn in upper Russian River between Upper and Lower Russian Lakes. Coho salmon also spawn in Upper Russian Lake tributary streams.

Upper Russian River enters Lower Russian Lake from the south and connects upper and lower Russian Lakes. Nelson (1976) has presented a detailed description of this stream and the Upper Russian Lake drainage. Figure 3 depicts the Upper Russian Lake drainage and delineates the spawning areas of both early and late runs.

Management and research associated with the Russian River sockeye salmon sport fishery has been conducted by the Sport Fish Division of the Alaska Department of Fish and Game since 1962. Prior information pertaining to this fishery has been presented by Lawler (1963-1964), Engel (1965-1972) and Nelson (1973-1982).

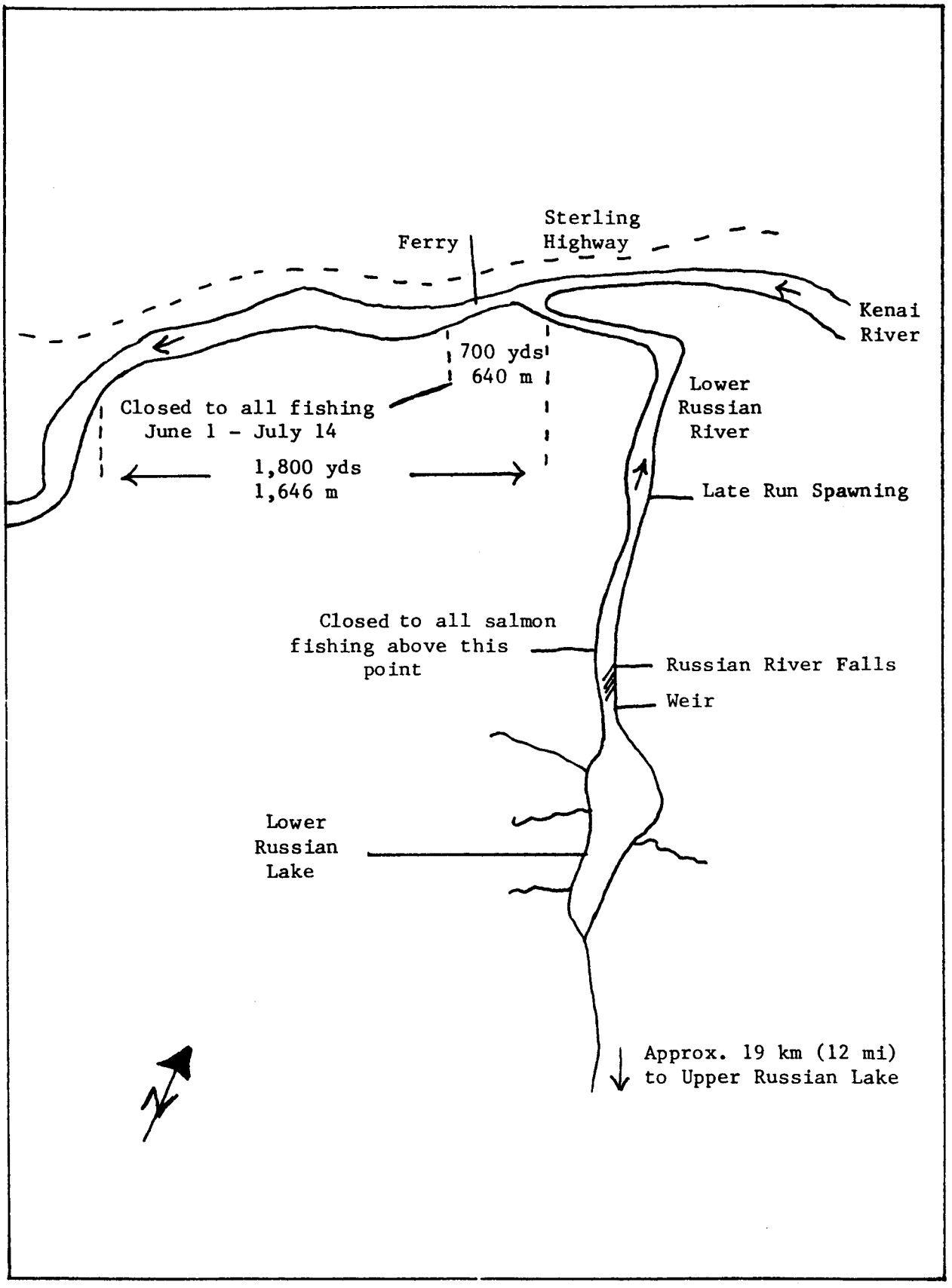

Figure 2. Schematic diagram of lower Russian River and Kenai and Russian River confluence (not to scale).

Table 1. A List of Common Names, Scientific Names and Abbreviations of Fish Species Found in Russian River Drainage.

Common Name	Scientific Name and Author	Abbreviation
Sockeye salmon	Oncorhynchus nerka (Walbaum)	RS
Chinook salmon	Oncorhynchus tshawytscha (Walbaum)	KS
Coho salmon	Oncorhynchus kisutch (Walbaum)	SS
Pink salmon	Oncorhynchus gorbuscha (Walbaum)	PS
Dolly Varden	Salvelinus malma (Walbaum)	DV
Rainbow trout	Salmo gairdneri Richardson	RT
Slimy sculpin	Cottus cognatus Richardson	SSC

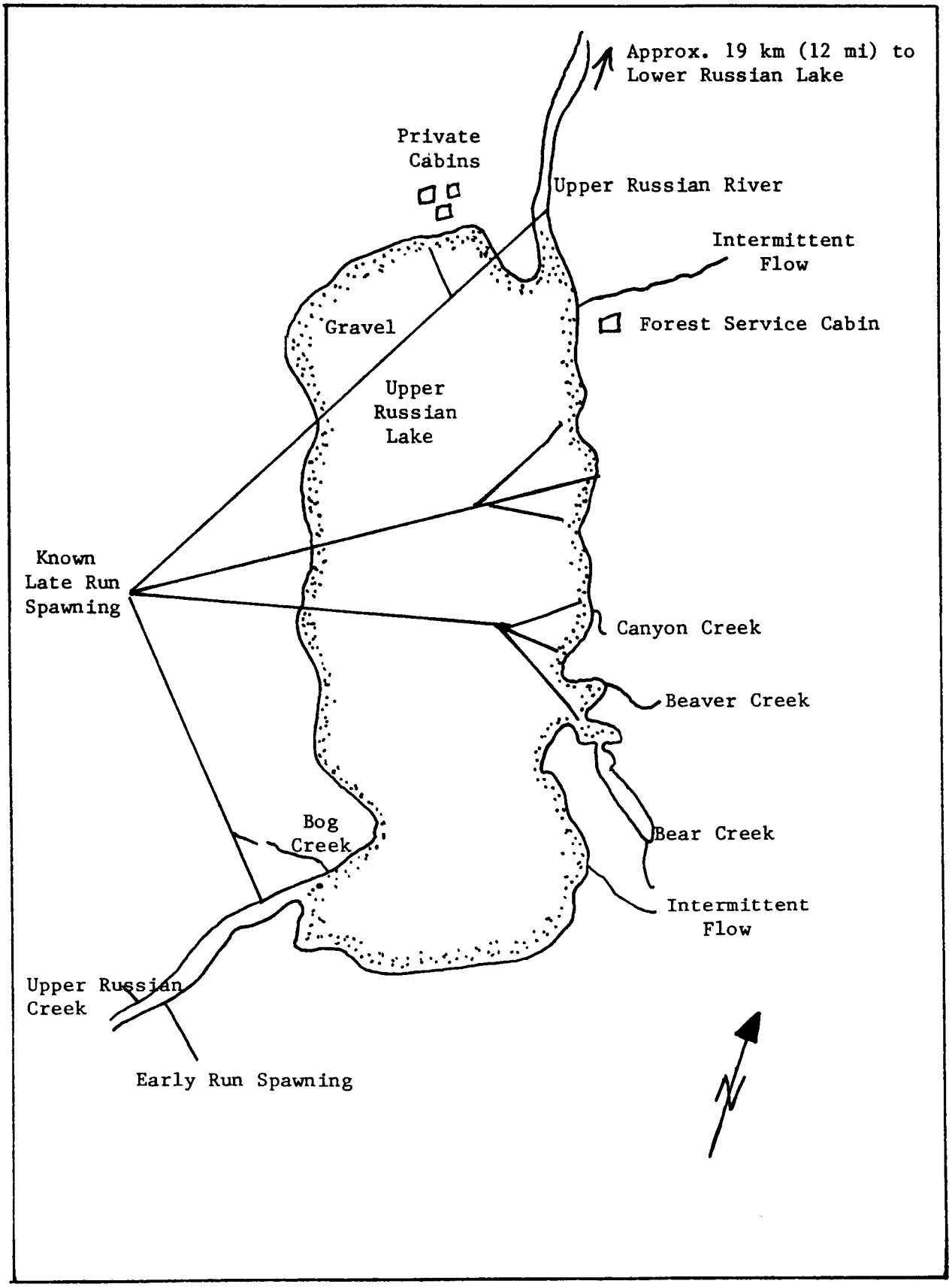

Figure 3. Schematic diagram of Upper Russian Lake (not to scale).

Despite a restrictive sport fishery which limits harvest methods and protects salmon in areas where they are concentrated, recreational demands upon the Russian River sockeye salmon resource has, at times, been greater than the stocks could sustain. This is evidenced in that the Sport Fish Division has closed all or part of the fishery on 18 different occasions since 1969 to increase spawning escapement levels. Numerous emergency openings and closings of the Russian River sockeye salmon fishery indicate it is the most intensely managed sport fishery in Alaska.

The Russian River program is currently directed toward "in-season" evaluation of stock status to determine the effects and effectiveness of current regulatory practices. Research activities emphasize the collection and evaluation of life history data. Objectives include determination of optimum escapement goals for both runs and ultimately predictions of sockeye salmon returns to Russian River.

RECOMMENDATIONS

1. The feasibility of artificially spawning and incubating early run Russian River sockeye salmon eggs should not be pursued at this time. Stocks are currently at high levels and additional investigation is required to ascertain the fry-rearing capacity of Upper Russian Lake. Introduction of additional fry into this fresh water rearing environment could decrease total early and late run production if Upper Russian Lake is at or near fry rearing capacity.

2. High water during the early run's spawning and incubation period in upper Russian Creek has not been positively established as a parameter limiting adult production. It is, therefore, not necessary to investigate stabilization of flow rates at this time.

3. Increase the bag and possession limit during the early run from one to three fish. This run is currently at high levels and the restrictive bag and possession limit is no longer required.

4. Management options associated with the operation of the Russian River fish pass should continue to be investigated.

5. Discontinue hydraulic sampling of early run sockeye salmon egg deposition in upper Russian Creek. Data reveal no correlation between egg deposition and adult production.

OBJECTIVES

1. To determine adult harvest of sport-caught early and late run Russian River sockeye salmon in the Russian River drainage.

2. To collect and analyze biological data concerning abundance and migrational timing of adult sockeye salmon in the Russian River drainage.

3. To determine age composition of adult early and late run Russian River sockeye salmon escapements enumerated at Lower Russian Lake weir.

4. To determine egg deposition of early-run spawning sockeye salmon in upper Russian Creek.

5. To determine the fecundity of early and late-run female sockeye salmon and to determine the relationship between fish length and mean number of eggs per sockeye salmon female.

6. To collect basic climatological data (precipitation, water and air temperature, stream discharge) at Lower Russian Lake and to determine the affect of these parameters on migrational timing of adult early and late run sockeye salmon.

7. To evaluate the effects and effectiveness of a fish pass at Russian River Falls.

8. To evaluate current regulations governing this sport fishery and to provide recommendations for future management and research.

TECHNIQUES USED

The 1982 Russian River creel census was a modification of the technique described by Neuhold and Lu (1957). Sampling procedures and data analyses were identical to those outlined by Engel (1965, 1970, 1972) and Nelson (1973, 1975).

Adult escapements were enumerated by weir at the outlet of lower Russian Lake. The present structure built in June 1975 replaced an earlier temporary weir described by Engel (1970) which had been employed since 1969. Nelson (1976) has presented a detailed description of the present structure.

Fecundities of late-run sockeye salmon were determined by random sampling at Lower Russian Lake weir. Sampling technique analyses have been described (Nelson, 1981). Early run fecundity was determined by regression analysis utilizing fecundity values from 1973-1981.

Scale samples to determine the age structure of the respective runs were collected at Lower Russian Lake weir. Age designation and methods to determine the adult age structure and male to female sex ratio have been presented (Nelson, 1978).

Potential egg deposition from the early run spawning escapement in upper Russian Creek was determined applying criteria previously described by Nelson (1976).

Water and air temperature at lower Russian Lake weir was determined by Taylor maximum-minimum thermometer. Precipitation was ascertained by a

gauge of standard manufacture. Stream depth was determined by a meter stick permanently attached to the stream bed since 1977. Velocity in 1982 was determined by correlating stream depth with known velocities from prior years. These values were periodically checked by Head Rod Method as described by Nelson (1977). Velocity of Rendezvous Creek, tributary to Russian River above Russian River Falls, was determined every other day by Head Rod Method.

FINDINGS

Creel Census

As noted, Russian River sockeye salmon runs are bimodal. During most years, the sport fishery is continuous as the latter segment of the early run is still present when the late run enters the fishery. This did not occur in 1981 (Nelson, 1982) or 1982. In 1982, the early run was complete by July 15. The late run did not arrive until July 24. No creel census was therefore conducted from July 16-23.

The census revealed anglers expended 51,480 man-days of effort, or 222,265 angler-hours, during the fishery. Effort directed toward early and late run stocks was estimated at 39,000 and 12,480 man-days, respectively. Angler effort in 1982 would have approached the record levels of 1977-1978 if an Emergency Order curtailing sockeye salmon fishing had not been required during the late run as a stock conservation measure.

Based on interviews with 2,862 anglers who reported harvesting 2,530 sockeye salmon, total catch was estimated at 44,820 fish. Early and late runs contributed 34,500 and 10,320 salmon, respectively, to this total. The 1982 total harvest is above the mean historical harvest of 21,955, but well below the record 1978 harvest of 62,250 early and late run sockeye salmon. As in angler effort, harvest is a reflection of total run strength.

Mean hourly catch rates were higher on weekdays (0.210) than on weekends (0.194) due to greater congestion on weekends which reduced individual angler efficiency. Seasonal catch per hour was 0.201 which is above the mean historical harvest rate of 0.176. Table 2 summarizes historical harvest, effort and catch per hour estimates since 1963.

Total weekday and weekend stream counts during the 1982 fishery averaged 256.0 and 423.4 anglers, respectively. These counts are exceptionally high and indicate crowded conditions on both weekends and weekdays. On Saturday, June 26, at 1300 hours, 1,012 anglers were concentrated in the "fly-fishing-only area", 500 at the confluence and the remainder upstream on Russian River. This is the highest instantaneous angler count recorded at Russian River. Sockeye salmon were available to the sport angler for 47 days in 1982. Average daily effort was in excess of 1,000 man-days.

Anglers fished an average of 4.3 and 4.5 hours on weekdays and weekends, respectively. These data approximate historic information in that the average angler fishes for a longer period of time on weekends than on weekdays (Table 3). Nelson (1979) suggested the time an average angler

Table 2. Estimated Sockeye Salmon Harvest, Effort and Success Rates on Russian River, 1963-1982.

Year	Harvest			Total Effort (Man-Days)	Catch/ Hour	Census Period
	Early Run	Late Run	Total			
1963	3,670	1,390	5,060	7,880	0.190	6/08-8/15
1964	3,550	2,450	6,000	5,330	0.321	6/08-8/16
1965	10,030	2,160	12,190	9,720	0.265	6/15-8/15
1966	14,950	7,290	22,240	18,280	0.242	6/15-8/15
1967	7,240	5,720	12,960	16,960	0.141	6/10-8/15
1968	6,920	5,820	12,740	17,280	0.134	6/10-8/15
1969	5,870	1,150	7,020	14,930	0.094	6/07-8/15
1970	5,750	600	6,350	10,700	0.124	6/11-8/15*
1971	2,810	10,730	13,540	15,120	0.192	6/17-8/30*
1972	5,040	16,050	21,090	25,700	0.195	6/17-8/21
1973	6,740	8,930	15,670	30,690	0.102	6/08-8/19*
1974	6,440	8,500	14,940	21,120	0.131	6/08-7/30*
1975	1,400	8,390	9,790	16,510	0.140	6/14-8/13*
1976	3,380	13,700	17,080	26,310	0.163	6/12-8/23*
1977	20,400	27,440	47,840	69,510	0.168	6/18-8/17
1978	37,720	24,530	62,250	69,860	0.203	6/07-8/09
1979	8,400	26,830	35,230	55,000	0.136	6/09-8/20*
1980	27,220	33,490	60,710	56,330	0.243	6/13-8/20
1981	10,720	23,720	34,440	51,030	0.156	6/09-8/20**
Mean	9,908	12,047	21,955	28,329	0.176	
1982	34,500	10,320	44,820	51,480	0.201	6/11-8/04

* Census period was not continuous during these years due to emergency closures required to increase spawning escapement levels.

** Census was not conducted from 7/7/81 through 7/14/81 as sport fishing harvest and effort during this period was negligible.

Table 3. Differences Between Weekday and Weekend Fishing Pressure and Rates of Success at Russian River, 1964-1982.

Year	Mean Angler Counts		Catch/Hour		Mean Hours Fished	
	Weekdays	Weekends	Weekdays	Weekends	Weekdays	Weekends
1964	29.6	70.6	0.444	0.209	3.3	3.9
1965	31.7	78.1	0.305	0.223	4.5	5.4
1966	53.2	143.1	0.297	0.183	4.8	5.5
1967	68.9	110.5	0.171	0.100	5.3	5.4
1968	71.5	124.9	0.153	0.107	5.3	5.8
1969	64.5	111.7	0.110	0.074	4.9	5.1
1970	83.5	127.8	0.140	0.100	4.8	4.7
1971	87.9	157.2	0.194	0.189	4.8	5.3
1972	73.3	138.5	0.203	0.187	4.0	4.4
1973	147.1	195.0	0.113	0.088	4.8	5.5
1974	123.8	144.4	0.164	0.085	4.7	5.7
1975	65.0	149.6	0.145	0.136	4.5	5.1
1976	72.5	134.4	0.165	0.161	3.5	4.5
1977	201.7	438.6	0.172	0.164	3.9	4.3
1978	264.1	425.7	0.205	0.191	3.9	4.2
1979	190.6	276.8	0.158	0.117	3.8	3.9
1980	299.1	317.8	0.270	0.210	4.2	4.7
1981	195.6	238.5	0.167	0.141	4.1	4.1
Mean	118.0	187.9	0.199	0.148	4.4	4.9
1982	256.0	423.4	0.210	0.194	4.3	4.5

spent on the stream was related to run strength. Sockeye salmon returned to Russian River in 1972, 1977 and 1978 through 1981 in record numbers. Average hours fished per angler per day during these years were less than the historical mean. The 1982 early run was the largest recorded. Anglers fished an average of 4.0 and 4.5 hours on weekdays and weekends, respectively. The 1982 late run was one of the smallest recorded. Anglers fished an average of 4.4 hours on weekdays and 5.1 hours on weekends. These data support the observation of the above author in that anglers fished fewer hours when salmon were numerous as opposed to a greater number of hours when few fish were available.

Stream counts revealed 48.3 and 77.2% of the anglers fished the confluence of the Kenai and Russian Rivers during the early and late run, respectively. The early run was the largest recorded and angler success rates were equally high in all areas. Fishing effort was, therefore, evenly distributed between the confluence and clear waters of Russian River. The late run return which spawns above Russian River Falls was one of the lowest recorded. A segment of the late run also spawns below Russian River Falls. These fish returned in record numbers. Early in the migration, both segments of the run were concentrated in the confluence area. The greatest concentration of anglers during the abbreviated late run fishery therefore occurred at the confluence of the Kenai and Russian Rivers.

Anglers harvested 38.1% of the early run stock returning to Russian River and 25.2% of the late. The early run exploitation rate closely approximates the historical mean of 37.7%. This harvest, however, is relatively low when viewed in relation to the record early run return (90,580). The late run harvest rate exceeded the historical mean by 5.1% and would have been higher had the fishery not been closed by Emergency Order to increase escapement levels.

Nelson (1976) reviewed angler participation trends at Russian River and postulated that angler effort would shift from its historical emphasis on the early run to late run stocks. This same author (Nelson, 1982) indicated this trend did not develop and that angler effort would be directed toward the more numerous stock rather than toward the early or late run per se. In 1982, the early run was the largest recorded and the late run return was below the historical mean. The early run provided 73.8% of the fishing opportunity and the late run 24.2% (Table 4). It is, therefore, evident that numbers of fish available to the sport angler dictates angling effort and that participation is independent of whether the most numerous stock is early or late run. Run timing, migrational rate and regulations pertaining to the respective runs will also influence angler participation, but numbers of sockeye salmon will be the primary parameter directing angler effort to either the early or late run.

During the census, 18 Dolly Varden, 10 rainbow trout and 1 Arctic grayling were creel checked. These data were not expanded as the fishery for these species occurs primarily after the sockeye salmon fishery. No coho or pink salmon were observed as these species arrived at Russian River after the sockeye salmon fishery was closed by Emergency Order and the creel census terminated.

Table 4. Angler Effort Directed Toward Early and Late Run Russian River Sockeye Salmon Stocks, 1963-1982.

Year	Effort (Man-Days)*		Effort (Percent)	
	Early Run	Late Run	Early Run	Late Run
1963	5,710	2,170	72.5	27.5
1964	3,980	1,350	74.7	25.3
1965	7,750	1,970	79.7	20.3
1966	11,970	6,310	65.5	34.5
1967	11,460	5,500	67.6	32.4
1968	11,780	5,500	68.2	31.8
1969	12,290	2,640	82.3	17.7
1970	9,700	1,000	90.7	9.3
1971	6,250	8,870	41.3	58.7
1972	12,340	13,360	48.0	52.0
1973	15,220	15,470	49.6	50.4
1974	11,090	10,030	52.5	47.5
1975	5,210	11,300	31.5	68.5
1976	8,930	17,380	33.9	66.1
1977	38,200	31,310	55.0	45.0
1978	51,910	17,950	74.3	25.7
1979	25,670	29,330	46.7	53.3
1980	31,430	24,900	55.8	44.2
1981	24,780	26,250	48.6	51.4
Mean	16,088	11,509	59.9	40.1
1982	39,000	12,480	75.8	24.2

* Man-day is defined as one angler fishing for one day irrespective of the number of hours fished.

In 1977, the Sport Fish Division initiated a Statewide Harvest Survey. It is from this survey that harvest estimates other than sockeye salmon are derived for Russian River (Nelson, 1982). Although harvest estimates for species other than sockeye salmon are not included as an Objective of the Russian River Study, the results of the survey, as they relate to Russian River, are summarized in Table 5 to maintain the continuity of the Sport Fish Division's research and management efforts on this popular Alaskan stream.

Rainbow trout and coho salmon harvest declined from 1980 estimates by 44.0 and 66.2%, respectively. No pink salmon were recorded in 1981, whereas 567 were reported harvested in 1980. The 1981 Dolly Varden harvest increased to a record high of 2,905, and Arctic grayling contributed 119 fish to the anglers' creels in 1981 as opposed to 69 in 1980.

Russian River was noted for its rainbow trout fishery in the 1930's and early 1940's. Fragmentary Federal records* indicate a harvest of 3,000-4,000 fish in 1940 with a number of these fish exceeding 762 mm (30 in) in length and 4.5 kg (10 lb) in weight. These records further indicated that at this early date Federal fisheries managers suggested this harvest was excessive and believed the fishery should be restricted. Although definitive data are not available, it is the general concensus of biologists and anglers familiar with the fishery that restrictions were not implemented in a timely manner and the rainbow trout population began a rapid decline in the 1940's.

Under State management, the bag and possession limit was 10 rainbow trout daily or in possession, only one of which could exceed 508 mm (20 in). There was no closed season. In 1980, this was amended by the Alaska Board of Fisheries and all fishing was prohibited from April 15 to May 31 in lower Russian River to afford this species total protection during the spawning period. In 1982, the bag and possession limit was further reduced to five.

The harvest of 1,437 fish in 1981 represents the second consecutive annual decline in the catch of this species. Reason(s) for the reduced harvest is not known and data are too limited to discern a definitive pattern. Observation by this author indicates that those fish presently harvested are not comparable in weight and length to the larger fish harvested in the 1930's and early 1940's.

The 1980 and 1981 total coho salmon return to Russian River was 4,214 and 5,025 fish, respectively. The larger return in 1981 produced a lesser harvest (340) than did the smaller 1980 (1,025 harvest) return. The converse would generally be expected to occur. As with rainbow trout, data are too limited to draw any conclusions, and it may be that the apparent decline in harvest is related soley to annual variability rather than to parameters such as population size, angler preference, water conditions, etc.

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* Records pertaining to the 1940 fishery are on file at the Department of Fish and Game, Box 3150, Soldotna, AK. 99669

Table 5. Estimated Russian River Harvest of Rainbow Trout, Dolly Varden, Coho Salmon, Pink Salmon and Grayling as Determined by Alaska Statewide Harvest Survey, 1977-1981.

Year	Species				
	Rainbow Trout	Dolly Varden	Coho Salmon	Pink Salmon	Grayling
1977	769	914	1,472	37	37
1978	2,423	2,588	1,466	1,300	18
1979	3,109	3,718	1,098	0	9
1980	2,566	2,256	1,025	930	69
Mean	2,217	2,369	1,260	567	33
1981	1,437	2,905	346	0	119

Pink salmon return to Russian River in harvestable numbers only on even years. That no pink salmon were harvest in 1981 is in agreement with the "odd/even" cycle of the species.

Dolly Varden in Russian River are second only in abundance to sockeye salmon. The record 1981 harvest of this species indicates the stocks are maintaining themselves at a high level.

Arctic grayling are not indigenous to the Kenai Peninsula. All populations currently established here are the progeny of an initial plant in 1952 of 240 sub-adults in Crescent Lake which is a tributary to the Kenai River (Engel, 1973). Although not numerous, a few grayling are harvested annually at the Russian/Kenai confluence area. Russian River habitat appears suitable for this species but no grayling have been observed in this stream by this author or reported by anglers. Increased harvest of this species in 1981 may be indicative of an expanding population at the confluence of the Kenai and Russian Rivers.

Escapement

The weir at the outlet of Lower Russian Lake was operational June 11, and the first early run sockeye salmon was passed on this date. This is 6 days prior to the mean historic (1960-1981) arrival date of June 18. Fifty percent of the early run was enumerated by July 3. Passage of this run was complete on July 23 (Table 6).

Early run spawning escapement was 56,080 fish. This is the largest early run escapement recorded, and the seventh consecutive year the early run has exceeded the minimum escapement goal of 9,000 fish (Table 7). Total early run return (harvest and escapement) was 90,580.

Late run fish began to pass the weir on July 24, 6 days later than their average annual arrival date. Fifty percent of the migration had passed the structure by August 4. Late run migration was complete on September 14, 15 days later than the mean annual termination of the run during years of weir operation.

Escapement of late run fish to Upper Russian Lake drainage was 30,630. An additional 45,000 late run fish spawned below Russian River Falls. This is the highest escapement recorded in this area. Total 1982 late run spawning escapement was therefore 75,630, or 25,183 salmon above the historic mean.

Total late run return (harvest and total escapement) was 85,950. This is well below the 1980 record return of 120,690, but exceeds the mean historic total return by 20,511 fish or 31.3% (Table 8).

Sixty-eight chinook salmon were enumerated at Russian River weir in 1982. This is more than twice the 1981 escapement of 30, but is still below the historical mean escapement of 143, to the upper Russian River drainage. An additional 35 chinook salmon were enumerated spawning in lower Russian River. Total escapement of 103 is the lowest spawning escapement recorded for this species. Coho salmon escapement was 2,291. This is below the previous 3 years, but the fourth consecutive year the escapement has

Table 6. Arrival Date, Fifty Percent of the Escapement Had Passed Russian River Weir/Counting Tower and Termination Date of Early and Late Russian River Sockeye Salmon Runs, 1960-1982.*

Year	Early Run			Late Run		
	Arrival at Weir/ Counting Tower	Date 50% Passed	Date Run Ended	Arrival at Weir/ Counting Tower	Date 50% Passed	Date Run Ended**
1960	June 19	June 26	July 15	July 16	Aug. 1	Aug. 12
1961	June 21	June 28	July 15	July 16	July 31	Aug. 28
1962	June 18	July 4	July 15	July 16	July 30	Aug. 31
1963	June 18	July 1	July 12	July 16	July 31	Aug. 23
1964	June 20	July 7	July 15	July 16	July 30	Aug. 15
1965	June 22	July 4	July 15	July 16	Aug. 5	Aug. 15
1966	June 20	June 29	July 15	July 19	July 30	Aug. 17
1967	June 20	June 28	July 15	July 19	Aug. 2	Aug. 18
1968	June 25	June 29	July 13	July 19	July 31	Aug. 14
1969	...	...	...	July 16	Aug. 2	Aug. 18
1970	June 17	July 5	July 15	July 16	Aug. 7	Aug. 23
1972	June 24	July 5	July 29	July 30	Aug. 5	Aug. 28
1973	June 21	July 6	July 15	July 16	Aug. 1	Aug. 30
1974	June 14	July 1	July 21	July 22	Aug. 7	Aug. 27
1975	June 25	July 6	July 27	July 21	Aug. 6	Sept. 1
1976	June 17	June 30	July 16	July 17	Aug. 2	Sept. 1
1978	June 10	July 2	July 24	July 2	July 30	Sept. 1
1979	June 8	June 27	July 15	July 16	July 29	Sept. 2
1980	June 14	June 29	July 20	July 21	July 30	Sept. 6
1981	June 12	June 25	July 17	July 18	July 28	Sept. 6
1960-81 Mean	June 18	July 1	July 17	July 17	Aug. 1	Aug. 25
1969-81 Mean***	June 16	July 2	July 20	July 18	Aug. 2	Aug. 30
1982	June 11	July 3	July 23	July 24	Aug. 4	Sept. 14

* Data from 1971 and 1977 were deleted due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.

** Date run ended or escapement enumeration discontinued for the season.

*** Years of weir operation.

Table 7. Russian River Sockeye Salmon Escapement and Harvest Rates for Early and Late Runs, 1963-1982.

Year	Escapement*			Percentage of Run Caught by the Sport Fishery		
	Early Run	Late Run	Total	Early Run	Late Run	Total
1963	14,380	51,120	65,500	20.3	2.0	7.2
1964	12,700	46,930	59,630	21.8	5.0	9.6
1965	21,710	21,820	43,330	31.8	9.0	21.6
1966	16,660	34,430	51,090	47.3	17.5	30.3
1967	12,710	49,480	63,190	34.6	10.3	17.0
1968	9,200	48,880	58,080	42.9	10.6	18.0
1969	5,000**	28,920	33,920	54.0	3.8	17.1
1970	5,450	28,200	33,650	51.3	2.1	15.9
1971	2,650	54,430	57,080	51.5	16.4	19.2
1972	9,270	79,000	88,270	35.2	16.8	19.3
1973	13,120	24,970	38,090	33.9	26.3	29.1
1974	13,150	24,650	37,800	32.9	25.6	28.3
1975	5,640	31,970	37,610	19.9	20.8	20.7
1976	14,700	31,950	46,650	18.7	30.0	26.8
1977	16,070	21,410	37,480	55.9	56.2	56.1
1978	34,150	34,230	68,380	52.5	41.7	47.7
1979	19,700	87,920	107,620	29.9	23.4	24.7
1980	28,670	83,980	112,650	48.7	29.7	35.0
1981	21,140	44,530	65,670	33.6	34.7	34.4
Mean	14,583	43,622	58,194	37.7	20.1	25.1
1982	56,080	30,630	86,710	38.1	25.2	34.1

* Escapement past weir. Commercial harvest and fish spawning downstream from Russian River weir are deleted.

** Escapement determined by foot survey from Upper Russian Creek.

Table 8. Late Run Russian River Sockeye Salmon Total Return and Escapement Enumerated Above and Below Russian River Falls, 1968-1982.

Year	Escapement Above Falls	Escapement Below Falls	Total Escapement	Percent of Escapement Below Falls	Sport Harvest	Total Return
1968	48,800	4,200	53,000	7.9	5,820	58,820
1969	28,920	1,100	30,020	3.7	1,150	31,170
1970	28,200	220	28,420	0.8	600	29,020
1971	54,430	10,000	64,430	15.5	10,730	75,160
1972	79,000	6,000	85,000	7.1	16,050	101,050
1973	24,970	6,690	31,660	21.1	8,930	40,590
1974	24,650	2,210	26,860	8.2	8,500	35,360
1975	31,970	690	32,660	2.1	8,390	41,050
1976	31,950	3,470	35,420	9.8	13,700	49,120
1977	21,410	17,090	38,500	44.4	27,440	65,940
1978	34,230	18,330	52,560	34.9	24,530	77,090
1979	87,920	3,920	91,840	4.3	26,830	118,670
1980	83,980	3,220	87,200	4.0	33,490	120,690
1981	44,530	4,160	48,690	8.5	23,720	72,410
Mean	44,640	5,807	50,447	12.3	14,991	65,439
1982	30,630	45,000	75,630	59.5	10,320	85,950

exceeded the historical mean. Russian River chinook and coho escapements are summarized in Table 9.

Relationship of Jacks to Adults

Jack (precocius males) sockeye salmon are generally not associated with the early sockeye salmon run. Jacks have been observed in the early run during only 5 of 12 years and then not in large numbers (Nelson, 1982). No jacks were present in the 1982 escapement. Jacks are more numerous during the late run and comprise 0.2 to 8.8% of the escapement. In 1982, 1,777 jacks were enumerated comprising 4.3% of the escapement to the Upper Russian Lake drainage (Table 10).

Nelson (1977) suggested a relationship may exist between numbers of jacks in the late run and the magnitude of the late run return the succeeding year. This author (Nelson, 1982) concluded that a relatively small jack return in a given year may be indicative of a less than average return the following year and that the converse may also be true. Historic data indicate this premise is true if applied as a generalization but that exceptions do occur.

The 1981 jack escapement of 2,634 was the second largest recorded during the late run. The 1982 return above Russian River Falls would therefore be expected to be above average. This did not occur and invalidates the above premises as an annual indicator of run strength.

Foerster (1968) has also noted that Age 1.2 sockeye salmon (jacks), "in some areas at least, appear in abundance in the year preceding a 'big' year". At Russian River this may only be true if the total return, to include late run fish harvested by the commercial fishery, are included in determining total late run return.

The number of commercial fishing periods allocated the Cook Inlet commercial fishery is dependent on total numbers of sockeye salmon returning to upper Cook Inlet. In 1982, additional fishing time was permitted because the return to this area was high. An above average percentage of late-run Russian River adult fish may therefore have been harvested leaving few fish to return to their natal stream. During years of low sockeye salmon returns to upper Cook Inlet, commercial fishing time is reduced. This may result in a relatively low harvest of Russian River fish and a correspondingly high return to Russian River. Jacks are not affected by the commercial fishery as they pass through the gill nets designed to capture the larger adults (Nelson, 1982).

Variable adult annual harvest rates in the Cook Inlet commercial fishery would therefore create a situation whereby the jack to succeeding year and adult relationship would display annual variation. If there was no commercial harvest or that fishery caught jacks in a constant proportion of adults, a more consistent and discernable jack to succeeding year adult relationship would be evident.

Table 11 compares the migrational timing of adults to late run jacks. Fifty percent of the adults may be expected to pass the weir by August 2, while 50% of the jack escapement is not enumerated until August 15, 13 days

Table 9. Estimated Coho and Chinook Salmon Spawning Escapements in Russian River Drainage, 1953-1982.

Year	Weir/Counting Tower Escapements		Lower River Escapement*	Total Escapement	
	Chinook	Coho	Chinook	Chinook	Coho
1953			85**		
1954			87**		
1955			42**		
1956			40**		
1957			44**		
1958			98**		
1966			182		
1967			126		
1968	56		63	119	
1969	119	70	31	150	70
1970	240	957	125	365	957
1971	21	839	149	170	839
1972	172	666	108	280	666
1973	243	200	104	347	200
1974	124	1,508	59	183	1,508
1975	102	4,000	32	134	4,000
1976	145	1,791	155	300	1,791
1977	37	1,884	145	182	1,884
1978	253	1,570	165	418	1,570
1979	280	2,400	82	362	2,400
1980	185	3,189	65	250	3,189
1981	30	4,679	91	121	4,679
Mean	143	1,827	94	241	1,827
1982	68	2,291	35	103	2,291

* Coho salmon do not spawn in lower Russian River.

** U.S. Fish and Wildlife Service data.

Table 10. Late Run Russian River Sockeye Salmon Harvest, Escapement and Returning Jacks, 1969-1982.

Year	Escapement	Harvest	Total Return*	Number of Jacks	Percent of Total Return
1969	28,920	1,150	30,070	352	1.2
1970	28,200	600	28,800	2,542	8.8
1971	54,430	10,730	65,160**	1,429	2.2
1972	79,000	16,050	95,050	160	0.2
1973	24,970	8,930	33,900	332	1.0
1974	24,650	8,500	33,150	1,008	3.0
1975	31,970	8,390	40,360	1,788	4.4
1976	31,950	13,700	45,650	1,204	2.6
1977	21,410	27,440	48,850	537	1.1
1978	34,230	24,530	58,760	2,874	4.9
1979	87,920	26,830	114,750	1,476	1.3
1980	83,980	33,490	117,470	1,533	1.3
1981	44,530	12,720	68,250	2,634	3.9
Mean	44,320	15,697	60,017	1,375	2.8
1982	30,630	10,320	40,950	1,777	4.3

* Excludes commercial harvest and late run sockeye salmon which spawn below Russian River Falls.

** Excludes an estimated 10,000 late run sockeye salmon which perished below Russian River Falls due to a velocity barrier.

Table 11. Migrational Timing of the Late Run Russian River Sockeye Salmon Jack Escapement Compared to the Migrational Timing of the Adult Escapement, 1970-1982.*

Year	Jack Escapement	Date 50% Past Weir	Adult Escapement**	Date 50% Past Weir	Timing Differential (Days)
1970	2,542	Aug. 10	25,658	Aug. 7	3
1972	160	Aug. 10	78,677	Aug. 4	6
1973	332	Aug. 6	24,642	July 31	6
1974	1,008	Aug. 12	23,639	Aug. 6	6
1975	1,788	Aug. 16	30,179	Aug. 5	11
1976	1,204	Aug. 18	30,746	Aug. 2	16
1978	2,874	Aug. 18	31,356	Aug. 2	16
1979	1,476	Aug. 15	87,920	July 29	17
1980	1,533	Aug. 19	82,450	July 30	20
1981	2,634	Aug. 22	41,896	July 28	25
Mean	1,555	Aug. 15	45,716	Aug. 2	13
1982	1,777	Aug. 19	28,853	Aug. 4	15

* Data from 1971 and 1977 were deleted due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.

** Escapement past the weir only. Sockeye salmon spawning below Russian River Falls are not considered.

later than the adults. In 1982, the timing differential between the passage of adults and jacks was 15 days. In 1980 and 1981, the disparity was 20 and 25 days, respectively, and from 1970-1979 it ranged from 3 to 17 days.

This timing differential may be a genetic trait, related to environmental factors or a combination thereof (Nelson, 1976). The author indicates water velocities through Russian River Falls generally decrease during the latter part of the late run migration and may facilitate the movement of smaller jacks through the falls. Larger adults may be more readily capable of negotiating the falls at greater velocities and therefore arrive earlier at the weir. Russian River was atypically high in both 1980 and 1981 which may account for the above average timing differential in those years. Water velocities were not excessive in 1982 and the timing differential of 15 days approximates the mean.

Migrational Rates in the Kenai River

Migrational rates within the Kenai River of Russian River stocks are limited to isolated tagging studies and a comparison of sonar counts to escapements enumerated at Russian River weir. Tagging studies have been reviewed (Nelson, 1977).

A sonar counter is located approximately 1.6 km (1 mi) below the Kenai River Bridge in Soldotna. This enumeration device is operated by the Commercial Fish Division of the Alaska Department of Fish and Game. Its primary function is to ascertain the late run Kenai River escapement, but it was used in 1978, 1979 and 1981 to determine the magnitude of the early Kenai River sockeye salmon return. Available data indicate this stock is of Russian River origin. Comparing sonar counts to weir escapement data, Nelson (1982) concluded early run fish migrated 3.2 km (2 mi) to 5.1 km (3.2 mi) per day.

Late run sockeye salmon sonar counts in the Kenai River, Russian River late run escapements and travel time between sonar counter and Russian River weir are presented in Table 12. Elapsed time between these two points from 1969-1981 ranged from 10 to 34 days averaging 14.6. Eliminating the 1969 and 1974 extremes, which appear to be atypical, decreases this range to between 10 and 13 days. The late run migrational rate would therefore be 7.2 (4.5 mi) to 9.3 km (5.8 mi) per day. It required 15 days for late run fish in 1982 to traverse the 93.5 km (58 mi) between sonar site and weir, or 6.2 km (3.9 mi) per day. Late run fish therefore migrate through the Kenai River more rapidly than do early run stocks. Reason(s) for these differing migrational rates is not known.

A comparison of sonar data and total Russian River late run return (harvest and escapement) provides an estimate of Russian River's contribution to the Kenai River sockeye salmon escapement. Table 13 indicates this contribution ranges from 8.7 to 66.9%. In 1982, Russian River accounted for 13.9% of the Kenai River late run sockeye salmon escapement.

Russian River Falls and Fish Pass

The fish pass at Russian River Falls was constructed during the winter of 1978-79 and employed for the first time on a limited basis during the 1979

Table 12. Kenai River Sockeye Salmon Sonar Counts Compared to Russian River Late Run Sockeye Salmon Escapements and Period of Travel Between Sonar Site and Russian River Weir, 1968-1982.*

Year	Sonar Count	Date 50% Passed	Russian River Escapement**	Date 50% Passed	Sonar to Weir (Days)
1968	88,000	July 19	48,800	July 30	11
1969	53,000	June 30	28,920	Aug. 2	34
1970	68,000	July 25	28,200	Aug. 6	13
1972	335,000	July 24	79,000	Aug. 4	12
1973	368,000	July 22	24,970	July 31	10
1974	157,000	July 17	24,650	Aug. 6	23
1975	143,000	July 24	31,970	Aug. 5	13
1976	381,000	July 20	31,950	Aug. 2	13
1978	399,000	July 18	34,230	July 30	12
1979	322,000	July 19	87,920	July 29	10
1980	464,000	July 19	83,980	July 30	11
1981	408,000	July 14	44,530	July 28	14
Mean	265,500	July 18	45,760	Aug. 4	14.6
1982	620,000	July 21	30,630	Aug. 4	15

* Data from 1971 and 1977 were deleted due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.

** Escapement passed the weir only. Sockeye salmon spawning below Russian River Falls are not considered.

Table 13. Kenai River Sockeye Salmon Sonar Counts, Total Late Run Russian River Sockeye Salmon Return and Percent of the Kenai River Late Run Sockeye Salmon Escapement to Enter Russian River, 1968-1982.*

Year	Sockeye Salmon Sonar Count	Total Late Run Russian River Return**	Percent Kenai Run to Russian River
1968	88,000	58,900	66.9
1969	53,000	31,170	58.8
1970	68,000	31,000	45.6
1972	335,000	101,050	30.2
1973	368,000	40,590	11.0
1974	157,000	35,360	22.5
1975	143,000	41,050	28.7
1976	381,000	49,120	12.9
1977	757,000	65,940	8.7
1978	399,000	77,090	19.3
1979	322,000	118,670	36.9
1980	464,000	120,690	26.0
1981	408,000	72,410	17.7
Mean	303,308	64,849	30.6
1982	620,000	85,950	13.9

* Sonar data from 1971 have been deleted due to equipment malfunction.

** Total late run Russian River return includes escapement passed weir, sport harvest and fish spawning below Russian River Falls.

sockeye salmon migration. It was concluded at this time that given an option at normal water flows, sockeye salmon would ascend the falls rather than utilize the fish pass (Nelson, 1980). The author (1981) noted that, during high water in 1980, mean passage rate through the fish pass was 510 fish/hour and the structure was operating as designed. Operation or inoperation of the fish pass during high water years could be employed to increase or decrease the rate of sockeye salmon migration. The structure could therefore be considered a management tool as the migrational rate of the stocks affect the degree to which the sport angler is capable of exploiting the resource.

Figure 4 indicates total discharge through Russian River Falls in 1982 approximated historic flow rates and did not exceed 300 cfs during either the early or late run. Nelson (1978) indicated that velocities which approached 400 cfs presented a barrier to sockeye salmon migration. Use of the fish pass to provide access to the Upper Russian Lake spawning grounds was therefore not required in 1982. As the salmon were confined exclusively to their preferred migratory route through the falls (Nelson, 1980), the structure could not be used as a management tool to increase or decrease migratory rates during the 1982 season.

Management of the 1982 Fishery

Early Run:

The early run arrived at the confluence of the Kenai and Russian Rivers on June 11. Catch rates were relatively low (0.11) during the first 3 days of the fishery but increased to an average of 0.22 during the succeeding 7 days. During this same period, the 700-yard "sanctuary area" was estimated to contain approximately 9,000 fish and large numbers of salmon were concentrated below Russian River Falls.
These data, coupled with the observations of the author, indicated minimum spawning escapement would be readily achieved and that existing regulations could be relaxed to permit an increased harvest. The 700-yard "sanctuary area" was therefore opened by Emergency Order and the restriction on fish bag and possession limit was raised to three by Emergency Regulation. Both the Emergency Order and Regulation became effective on June 24 at 6:00 pm.

Early run harvest and escapement was 34,500 and 56,080 salmon, respectively. Had the above management options not been exercised, harvest would not have been maximized and the escapement would have been even greater. The total early run return of 90,580 is the largest early run return recorded. These fish migrated through the fishery at what may be termed a "normal rate" and were available to the sport angler for 35 consecutive days. Campgrounds, operated by Federal land managing agencies, were routinely filled to capacity. The Russian River received an average of 1,114 man-days of effort for each day this stock was present.

Late Run:

The late run entered the recreational fishery on July 24. Observation and creel census data indicated catch rates were relatively high at the confluence area and correspondingly low in Russian River. Few late-run fish were observed in Russian River Falls and escapement levels were below historic

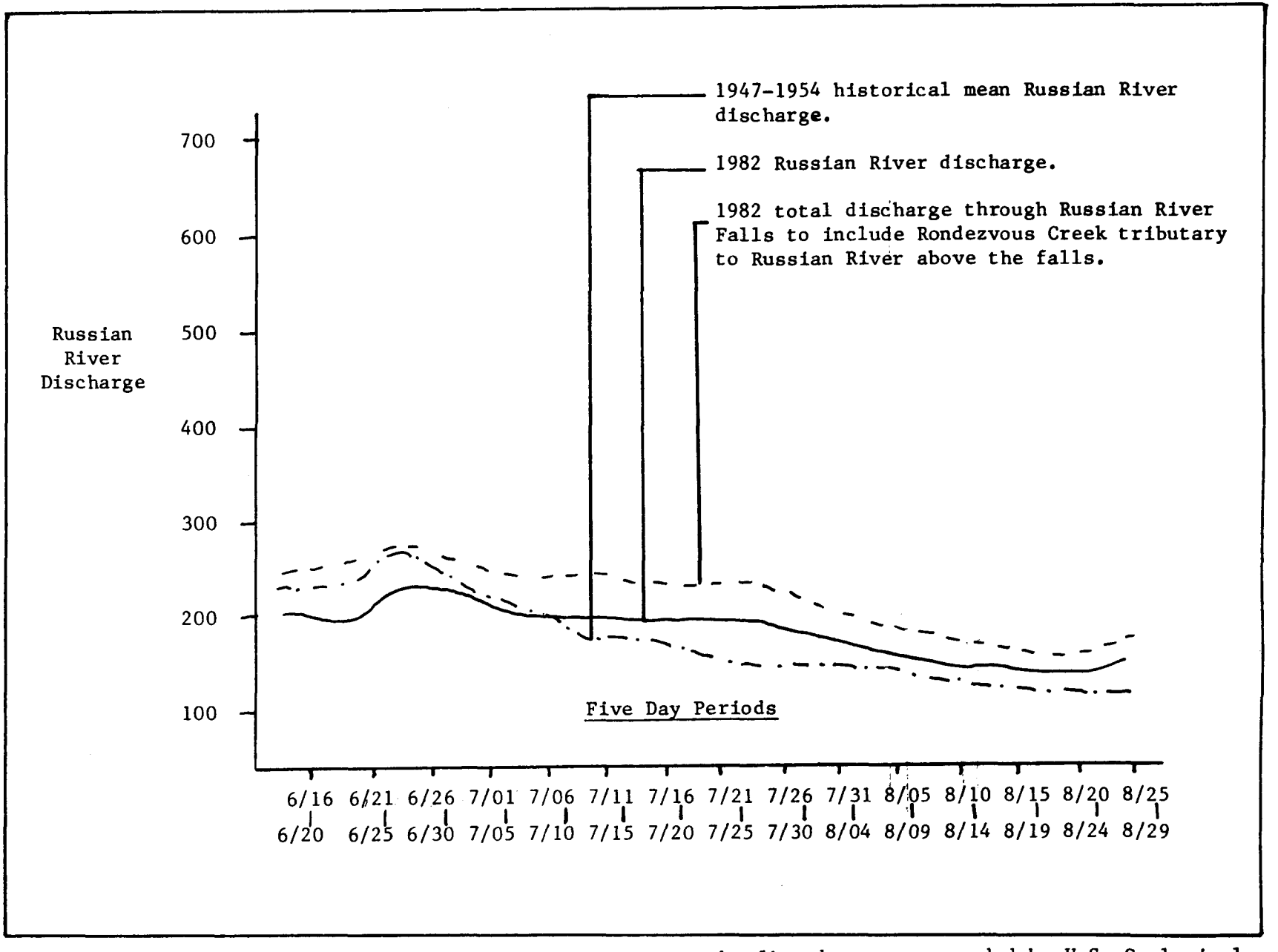

Figure 4. Mean (eight year) Russian River discharge rates by five day mean recorded by U.S. Geological Survey from 1947 through 1954 compared to 1982 discharge rates.

passage rates. It was concluded that the majority of those fish contributing to the high confluence catch rates were a segment of the late run which spawns below Russian River Falls rather than late run fish which spawn in Upper Russian Lake drainage.

On August 5, the escapement above the falls was a relatively low 16,600 sockeye salmon, and it became evident that without conservative measures the minimum escapement goal of 30,000 fish would not be achieved. The fishery was closed for the remainder of 1982 by Emergency Order on that date.

During the abbreviated 12-day fishery, 12,480 man-days were expended to harvest 10,320 fish. Observation indicates that no more than 50% of the harvest was comprised of that stock which spawns in the Upper Russian Lake drainage. The fishery was exceptionally intense, as over 1,000 man-days of angler effort occurred each day of the fishery.

As previously noted in this report, a segment of the late run spawns below Russian River Falls. This population does not usually contribute significantly to the sport fishery as these fish begin to sexually mature while in the Kenai River and have assumed spawning coloration prior to entering Russian River. Anglers generally consider fish which have assumed spawning coloration aesthetically unacceptable. The population which spawns in Upper Russian Lake drainage does not begin to sexually mature until it enters Upper Russian Lake. The degree of sexual maturation of fish harvested in the fishery may therefore be used by trained observers to separate stocks which spawn in Upper Russian Lake drainage from those which spawn in lower Russian River.
From 1968 to 1981, the population which spawns in lower Russian River has averaged 5,807 or 12.3% of the total escapement. In 1982, 45,000 fish spawned in this area and contributed 59.5% to the escapement. It is assumed these fish are similar in age structure to late run Kenai River sockeye salmon; i.e. 1.3 or 5-year fish. They are the progeny of 17,090 salmon which spawned in 1977. The 1977 escapement was the highest recorded to date (see Table 8).

The return of large numbers of fish to the spawning area in lower Russian River has management implication in that in a given situation they do contribute to the harvest in the confluence area. Anglers will retain these fish if sexually immature "bright" fish from the population which spawns above Russian River Falls are not numerous. This occurred in 1982. The retention of those fish which spawn below Russian River Falls may result in high catch rates which are generally interpreted as indicative of a large return of fish which spawn in Upper Russian Lake drainage.

A reliance soley on angler catch rates to assess the strength of those stocks which spawn in Upper Russian Lake drainage in years when the lower Russian River return is high may therefore result in over exploitation of the former stock. Observation and differentiation of the stocks in the sport harvest should be given greater credence than catch rates in determining the relative magnitude of that population which spawns in Upper Russian Lake drainage.

Historically, 72.2% of the late run fish which spawn in Upper Russian Lake drainage are 5 years of age. The 1982 return was therefore the progeny of those fish which spawned in 1977. In 1977, high water through Russian River Falls blocked the late run migration necessitating a "fish rescue" by the Department of Fish and Game. Sockeye salmon were captured at the base of the falls and transported over the barrier via helicopter. A total of 7,436 late run fish were transported in this manner and an additional 13,947 negotiated the falls prior to and after the high water period. These fish, as well as those transported via helicopter, experienced stressful delay as well as abrasive injuries in the turbulent water. The condition of these fish cast doubt on their ability to spawn successfully (Nelson, 1978). Additionally, the total 1977 escapement of 21,401 was the lowest recorded in the history of the fishery. A below-average return of this stock in 1982 was not unexpected.

Paradoxically, sockeye salmon returned in record numbers to other upper Cook Inlet drainages in 1982. The Cook Inlet commercial fishery was allocated additional fishing periods above the regularly scheduled two 12-hour periods. The set nets on Cohoe and Ninilchik beaches fished 338 hours above base fishing time. Kalifonski and Salamatoff beaches each fished 308 hours above the base of two regularly scheduled 12-hour periods. Additional commercial fishing periods undoubtedly increased the harvest of late run Russian River stocks which spawn in Upper Russian Lake drainage. Available data, however, suggest that the additional commercial harvest can only be considered a contributing rather than the primary cause of the below average 1982 return.

Those fish which spawn above Russian River Falls return to Russian River at the same time as those fish which spawn in lower Russian River. It is assumed that both stocks have similar migrational timing in Cook Inlet and are harvested in the commercial fishery in direct proportion to their abundance. If an increased harvest was the primary cause of the low return of that stock which spawns in Upper Russian Lake drainage, it would seem that the stock which spawns in lower Russian River would be similarly affected. This did not occur. It is concluded that adverse environmental factors in 1977 were the primary reason for a low return in 1982 of that stock which spawns in Upper Russian Lake drainage and that this low return was only secondarily related to the 1982 commercial fishery.

Status of the Russian River Stocks and Fishery

Status of the stocks and fishery is provided by comparing historic total return, spawning escapement, harvest and man-days of effort with similar data from the last cycle.* Early run total return has increased from the historic mean of 17,209 to 52,462 fish during the last cycle, an increase of 204.9%. Similarly, the spawning escapement and harvest increased 160.7 and 287.0%, respectively. The minimum spawning escapement (9,000) has been achieved each year of the last cycle. Anglers have enjoyed excellent success rates during the last 6 years, and the average number of man-days of angler effort expended during the early run fishery increased from 9,549 to 35,165.

*The early run cycle is 6 years and the late run cycle 5 years.

The late run is characterized by similar but less dramatic increases during the last cycle. Total return and spawning escapement increased 71.9 and 45.9%, respectively. The mean harvest increased from 8,021 to 23,778 salmon. Angler effort increased 148.0% and 1 man-day of fishing effort produced 1.1 late run sockeye salmon. Historically, 1 man-day 0.9 fish. The minimum spawning escapement (30,000) has been achieved in 4 years of the last 5-year cycle. The exception was 1977 in which a velocity barrier at Russian River Falls complicated management of the fishery (Nelson, 1978).

Combining early and late run data indicates during the last cycle total return, spawning escapement, harvest and man-days of effort increased 90.3, 63.8, 233.1 and 216.8%, respectively (Table 14). Russian River stocks are therefore maintaining themselves at a high level and are supporting an expanding fishery.

Age Class Composition

Scale samples collected at Lower Russian Lake weir revealed sockeye salmon in their sixth year of life comprised 98.4% of the early run. Salmon is their fifth year of life contributed the remaining 1.6%. Age class 2.3 has historically contributed 66.2%. The contribution of 98.4% in 1982 is the greatest recorded but is not considered atypical due to the historic dominance of this age class in the early run.

Early run salmon averaged 589.5 mm (23.2 in) in length. Mean lengths of two and three-ocean fish were 540.0 mm (21.3 in) and 589.7 mm (23.2 in), respectively.

Late run stocks were also dominated by fish which resided 2 years in freshwater (85.2%). The majority of the run (56.8%) spent 2 years in saltwater prior to returning to their natal stream. Male to female sex ratio (excluding jacks) was 1:1.3. Late run sockeye salmon averaged 559.7 mm (22.0 in) in length, 29.8 mm (1.2 in) less than the average early run fish. This length differentiation occurs annually and has been previously discussed (Nelson, 1982).

Two and three-ocean late run fish averaged 531.1 mm (20.9 in) and 597.2 mm (23.5 in), respectively. Two and three-ocean late run fish are larger than early run fish of similar ocean residence, as the late run remains in the marine environment approximately 1 month longer than early run fish during their final year of life. Lengths of early and late run fish sampled since 1975 are presented in Table 15. Age class composition data of the 1982 early and late run are presented in Table 16.

Table 17 summarizes historical early and late run Russian River sockeye salmon age class composition. The dominance of age class 2.3 in the early and 2.2 in the late run is clearly shown. The exception to the dominance of age class 2.3 fish in the early run occurred in 1977 and 1981. The atypical age structure during these years has been discussed (Nelson, 1978, 1982). Age class 2.2 has consistantly been the prevalent age class in the late run.

Table 14. Early and Late Run Russian River Sockeye Salmon Harvest, Effort, Spawning Escapement and Total Returns of the Last Cycle Compared to Similar Historic Data.

Period	Fishing Effort (Man-Days)	Harvest	Spawning Escapement*	Total Return**
		Early Run		
Historic (1963-1976)	9,549	5,985	11,239	17,209
Last Cycle (1977-1982)	35,165	23,160	29,302	52,462
Percent Increase (Historic to Last Cycle)	268.3	287.0	160.7	204.9
		Late Run		
Historic (1963-1977)	8,944	8,021	38,544	46,565
Last Cycle (1978-1982)	22,182	23,778	56,258	80,038
Percent Increase (Historic to Last Cycle)	148.0	196.4	45.9	71.9
		Combined		
Historic**	9,236	7,038	25,362	62,627
Last Cycle***	29,264	23,440	41,544	119,160
		Combined		
Percent Increase (Historic to Last Cycle)	216.8	233.1	63.8	90.3

* Spawning escapement are those fish which pass through Russian River weir and spawn in the Upper Russian Lake drainage. Excluded are those late run fish which spawn below Russian River weir in lower Russian River.

** Total return is sport harvest plus spawning escapement to the Upper Russian Lake drainage. Late run fish spawning in lower Russian River and the Cook Inlet commercial harvest are not considered.

*** Historic data for the early run are 1963-1976 as these are six year fish. The last cycle is from 1977-1982. Late run sockeye salmon are five year fish. Historic data are from 1963-1977 and the last cycle 1978-1982.

Table 15. Early and Late Run Russian River Sockeye Salmon Total Returns and Mean Lengths by Ocean-Age of Fish Sampled, 1975-1982.

Year	Total Return**	Mean Length (mm)* Two-Ocean Salmon	Three-Ocean Salmon	Combined
		Early Run		
1975	7,040	542.1	600.7	588.7
1976	18,090	562.4	609.4	591.5
1977	36,470	559.6	610.5	598.2
1978	71,870	551.5	604.5	602.0
1979	28,100	550.1	610.8	605.3
1980	55,890	543.5	597.1	595.8
1981	31,860	549.8	601.8	588.3
Mean	34,712	551.3	605.0	595.7
1982	90,580	540.0	589.7	589.5
		Late Run		
1975	40,360	552.2	603.2	561.3
1976	45,650	571.5	618.6	585.0
1977	48,850	553.7	614.9	570.5
1978	58,760	549.8	602.7	566.9
1979	114,750	541.6	610.3	548.0
1980	117,480	544.2	600.9	562.7
1981	68,250	544.8	608.9	560.5
Mean	70,586	551.1	608.5	565.0
1982	40,950	531.1	597.2	559.7

* Lengths are from mid-eye to fork of tail.

** Total return is exclusive of sockeye salmon spawning below Russian River Falls.

Table 16. Age Class Composition, Sample Size, Parent Year and Mean Lengths of Adult Sockeye Salmon in Respective Age Classes For Early and Late Run Russian River Escapements, 1982.

Age Class	Estimated Number in Escapement	Sample Size	Estimated Percent of Escapement	Parent Year	Mean Length (mm)*	S.D.**
			Early Run			
1.3	673	3	1.2	1977	591.7	33.3
2.2	224	1	0.4	1977	540.0	...
2.3	55,183	240	98.4	1976	589.7	16.9
Combined	56,080	244	100.0		589.5****	17.3****
			Late Run			
1.2	2,541	22	8.8	1978	514.3	29.5
1.3	809	7	2.8	1977	592.1	11.5
2.2	13,283	115	46.0	1977	534.1	25.3
2.3	11,320	98	39.2	1976	598.1	19.9
3.2	577	5	2.0	1976	541.0	50.5
3.3	347	3	1.2	1975	578.3	17.5
Combined	28,877***	250	100.0		559.7****	40.9****

* Mean lengths are from mid-eye to fork of tail.

** Standard deviation.

*** Excludes 1,753 jacks.

**** Mean lengths and standard deviation computed from total sample.

Table 17. Age Class Composition in Percent of Early and Late Run Adult Russian River Sockeye Salmon Escapements, 1970-1982.

Year	Age Class 1.2	1.3	1.4	2.2	2.3	2.4	3.2	3.3
				Early Run				
1970	0.4			8.9	87.1	3.6		
1971	1.1	3.2		6.4	89.3			
1972	3.0	38.0		8.4	50.0	0.6		
1973	...	...		...	...	...	...	...
1974	0.5	32.0		3.4	63.6	0.5		
1975	0.4	1.8	0.4	19.7	75.1	0.4		
1976	16.8	1.5		11.4	61.1		0.9	1.3
1977	1.9	60.7		14.0	23.4		0.8	8.4
1978	0.9	3.0		1.6	95.3			
1979		4.5		20.9	74.6			
1980	6.2	8.1	0.4	4.3	81.0			
1981	6.3	46.5		18.9	28.3			
Mean*	3.4	18.1	0.1	10.7	66.2	0.5	0.1	0.9
1982		1.2		0.4	98.4			
				Late Run				
1970	2.5	2.9		87.3	7.3			
1971	1.9	5.3		61.5	30.3			
1972	...	...		...	...	...	...	...
1973	...	...		...	...	...	...	...
1974	5.5	9.0		58.6	26.9			
1975	5.4	2.9		65.9	23.9		1.9	
1976	10.9	4.3		59.6	23.6		1.0	0.6
1977	6.6	7.7		72.6	13.1			
1978	0.9	5.3		58.8	35.0			
1979	2.1	0.4		88.2	8.2		0.9	0.2
1980	25.2	7.4		56.6	10.8			
1981	13.8	6.6		60.2	18.9		0.5	
Mean**	7.5	5.2		66.9	19.8		0.4	0.2
1982	8.8	2.8		46.0	39.2		2.0	1.2

* Data are not available for 1973. Eleven year mean.

** Data are not available for 1972 and 1973. Ten year mean.

Length frequency of 244 early run sockeye salmon is presented in Figure 5. This figure indicates 74.5% of these fish exceeded 580 mm (22.8 in) whereas Figure 6 reveals only 38.8% of the late run exceeded this length. This length differential is again a function of the age structure of the respective populations.

Given the basic premise that early and late runs are comprised of two and three-ocean salmon, Figure 5 indicates a division of ocean ages at 559 mm (22.0 in). Calculating the ocean age of early run fish employing these length frequency data reveals 1.6% of the run would be two-ocean and 98.4% three-ocean. Scale analysis indicates 0.4% and 99.6% were two and three-ocean fish, respectively. Length could therefore be employed as an indicator of ocean age for the 1982 early run.

Figure 6 does not indicate a division of ocean age for late run fish. A diversity of length frequencies are present ranging from < 500 mm (19.7 in) to > 650 mm (26.6 in). Nelson (1979) indicated accurate determination of the length of ocean residency was not always possible employing length as the sole criteria. This author indicated in 1978 that a division based on length data was not in agreement with age class composition data obtained from scale analysis for either the early or late run.

Early Run Return Per Spawner

Table 18 presents the numbers of fish produced for each early-run fish in the parent year spawning escapement. From 1963-1975, the return per spawning fish in the parent year escapement averaged 2.6, ranging from 0.2 to 10.6. The significance of a return of 10.6 for each salmon in the escapement has been discussed (Nelson, 1979). The author also noted a large spawning escapement does not necessarily ensure a high return rate. The lowest return per spawner (0.2) was produced by one of the largest parent year escapements (21,510). Conversely, the return rate of 10.6 originated with a relatively low spawning escapement in 1972 of 9,270.

Foerster (1968) indicates that irrespective of the level of escapement, the fluctuations in the numbers of returning adult fish are quite marked. The Fraser River return per spawner from 1938 to 1954 ranged from 2.2 to 13.0, averaging 5.4. The author concludes most of the variability in production is attributable to environmental conditions during the fresh water developmental stages.

Return per spawner for the 1976 parent year, which returned as adults in 1981 and 1982, was 7.7. This is well above the historic mean return of 2.6 and is second only to the record 1972 return rate of 10.6.

Fecundity Investigations

Fecundity investigations initiated in 1973 were continued during the 1982 season. Data from 1982 late-run investigations are presented in Table 19.

Early-run fecundity samples were not analyzed due to a failure of the refrigeration unit in which they were temporarily stored. Regression analysis of previous data between length (x) and fecundity (y) yielded a mean early-run fecundity of 3,479 eggs/female. Correlation coefficient for

Table 18. Estimated Production From Known Escapements of Early Run Russian River Sockeye Salmon.

Parent Year	Parent Year Escapement	Total Return* (Production)	Return Per Female	Return Per Spawner
1963	14,580	10,870	1.5**	0.7**
1964	12,700	11,200	1.8**	0.9**
1965	21,510	4,875	0.4**	0.2**
1966	16,660	8,183	1.0	0.5
1967	13,710	19,628	2.8	1.4
1968	9,200	18,946	4.0	2.0
1969	5,000	14,508	5.8	2.9
1970	5,450	12,810	5.3	2.3
1971	2,650	10,896	8.7	4.1
1972	9,270	98,775	26.6	10.6
1973	13,120	24,962	3.8	1.9
1974	13,150	52,704	9.7	4.0
1975	5,640	15,947	4.6	2.8
Mean	10,972	23,408	5.8	2.6
1976	14,700	113,432	16.3	7.7

* Total return equals sport harvest plus escapement. A negligible commercial harvest is assumed.

** Assumes a male to female sex ratio of 1:1.0 in the parent year escapement. Sex ratios for succeeding years determined by sampling.

Table 19. Fecundity of Late Run Russian River Sockeye Salmon as Determined by Sampling of Lower Russian Lake Weir, 1982.

Sample Number	Weight kg	Weight lb	Length (mm)	Number of Eggs Right Skein	Number of Eggs Left Skein	Number of Eggs Combined
1	2.7	5.9	585	1,879	2,134	4,013
2	2.5	5.6	570	1,386	1,467	2,853
3	2.9	6.3	615	2,051	2,143	4,194
4	2.7	6.0	605	1,867	2,072	3,939
5	3.2	7.1	620	1,938	2,363	4,301
6	2.9	6.5	610	1,239	1,983	3,222
7	2.9	6.3	605	1,947	2,073	4,020
8	2.7	5.9	585	1,769	1,987	3,756
9	2.8	6.1	610	1,739	1,993	3,732
10	2.7	5.9	570	1,858	2,180	4,038
11	2.7	6.0	595	1,649	2,033	3,682
12	2.0	4.4	550	1,251	1,427	2,678
Mean	2.7	6.0	593.3	1,714.4	1,987.9	3,702.3

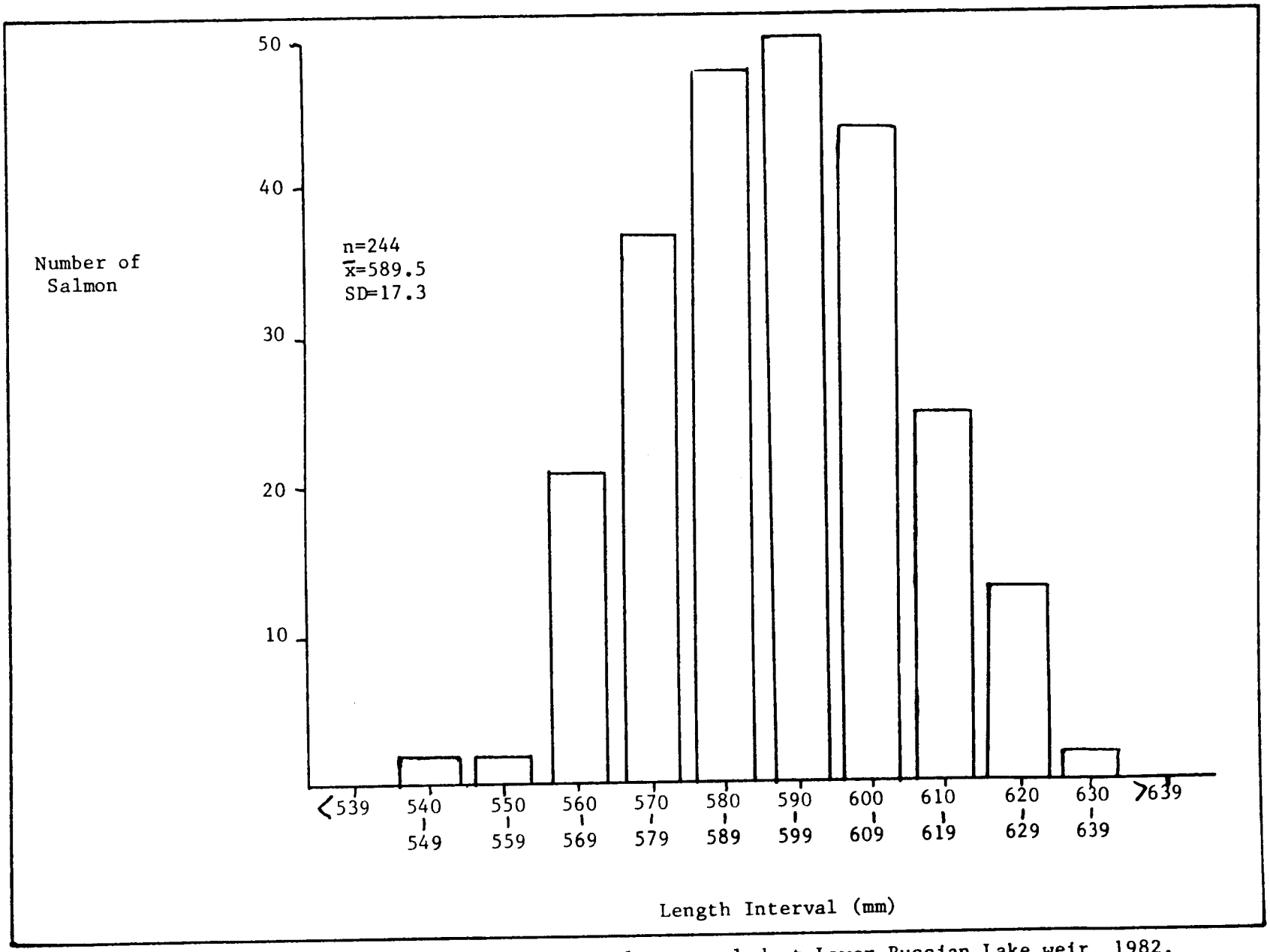

Figure 5. Length frequency of early run sockeye salmon sampled at Lower Russian Lake weir, 1982.

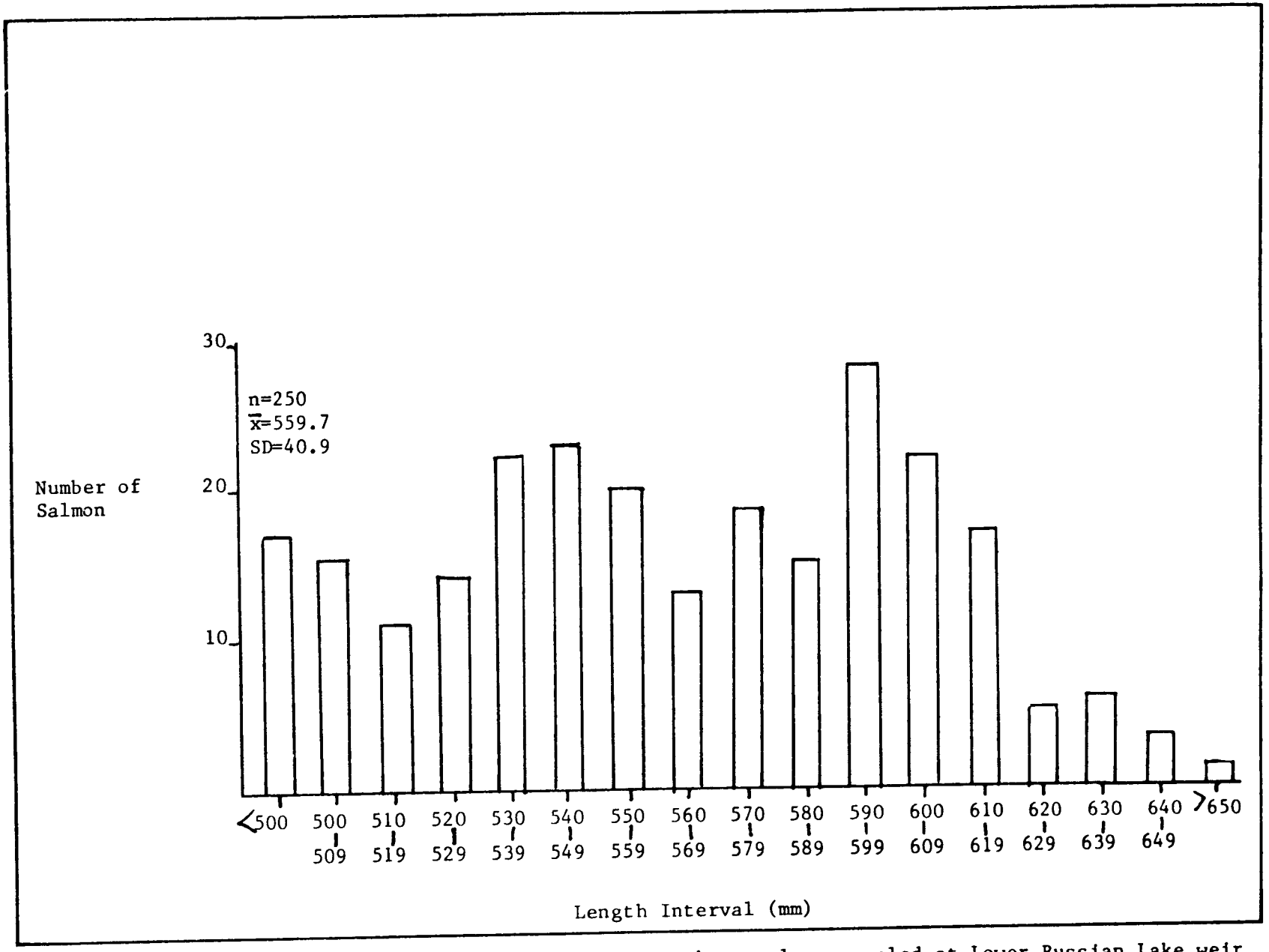

Figure 6. Length frequency of late run Russian River sockeye salmon sampled at Lower Russian Lake weir, 1982.

this regression was 0.75. These fish therefore averaged 1,318 eggs/kg of body weight and 5.9 eggs/mm of body length. Mean weight and length of early-run females was 2.64 kg (5.8 lb) and 587.7 mm (23.1 in), respectively.

Mean weight and length of late-run fish sampled were 593.3 mm (23.3 in) and 2.72 kg (6.0 lb). These fish averaged 1,361 eggs/kg of body weight and 6.2 eggs/mm of body length. Mean fecundity was 3,702 eggs/female. Table 20 compares early and late-run fecundity data with results from prior investigations.

This table indicates fecundity and related data recorded in 1982 are within the range of historic values for early-run sockeye salmon. Late-run fish sampled were larger (both weight and length) than those sampled in prior years. Mean fecundity is also the highest recorded. This is the first year the fecundity of the late run exceeded the mean fecundity of early-run fish.

Egg Deposition

Assuming the mean fecundity of early-run fish is representative of early-run stocks, the potential number of eggs available for deposition in upper Russian Creek may be calculated. Losses between weir and spawning grounds, females which perish without spawning and mean number of eggs retained per spent female must be considered. Nelson (1976) has presented a detailed discussion of these criteria and the methodology employed to calculate potential early-run egg deposition. Deposition in 1982 was estimated at 89.7 million. Table 21 presents early-run potential egg deposition estimates since 1973.

Inspection of Table 21 reveals the greater the spawning escapement, the greater the potential egg deposition. However, some variability in reproductive potential will occur annually, irrespective of the number of salmon in the spawning escapement in that mean fecundity and male to female sex ratio are not constant (Hartman and Conkle, 1960). It would also be noted that neither a definitive nor direct relationship is evident between numbers in the spawning escapement, potential eggs available for deposition and adult return. Factors other than eggs available for deposition therefore exert a significant influence on the adult return of early run sockeye salmon. Foerster (1968) believes these factors are manifest primarily during freshwater residency and are environmentally related.

Egg sampling to determine actual egg deposition in upper Russian Creek was not conducted in 1982. It was previously believed that hydraulic egg sampling would permit an evaluation of spawning success (number of eggs deposited) as this success was related to environmental parameters present during the spawning and early portion of the egg incubation period. It was further assumed that there was a direct relationship between egg density and the return of adult early run fish 6 years later. Data analysis reveals this latter assumption is not valid.

Nelson (1982) indicated the presence or absence of high water during the spawning and incubation period would, to a high degree, influence egg density in upper Russian Creek. The author indicated high water conditions

Table 20. A Comparison of Fecundity Data Collected at Lower Russian Lake Weir During Early and Late Run Russian River Sockeye Salmon Migrations, 1973-1982.

Year	Mean Fecundity	Mean Length (mm)	Mean Weight (kg)	Eggs/ Kilogram	Eggs/ Millimeter
			Early Run		
1973	4,630	627.0	2.97	1,559	7.4
1974	3,569	603.0	2.60	1,373	5.9
1975	3,952	600.0	2.54	1,556	6.6
1976	3,668	596.0	2.61	1,405	6.1
1977	4,313	602.7	2.85	1,513	7.1
1978	3,815	608.1	2.82	1,353	6.3
1979	3,842	577.0	2.49	1,543	6.7
1980	3,534	572.9	2.42	1,460	6.2
1981	3,412	570.4	2.32	1,471	6.0
Mean	3,859.4	595.2	2.62	1,470.3	6.5
1982	3,479*	587.7	2.64	1,318	5.9
			Late Run		
1973	3,190	569.0	2.19	1,457	5.6
1974	3,261	558.0	2.30	1,418	5.8
1975	3,555	555.0	2.26	1,573	6.4
1976	3,491	587.0	2.53	1,380	5.9
1977	3,302	567.1	2.44	1,353	5.8
1978	2,865	584.0	2.67	1,073	4.9
1979	3,314	542.0	2.20	1,506	6.1
1980	2,740	543.7	1.98	1,384	5.0
1981	3,268	551.7	2.15	1,520	5.9
Mean	3,220.7	561.9	2.30	1,407.1	5.7
1982	3,702	593.3	2.72	1,361	6.2

* Fecundity calculated by linear regression. Correlation coefficient between length (x) and fecundity (y) equals 0.75.

Table 21. Potential Egg Deposition From Early Run Sockeye Salmon Escapement in Upper Russian Creek and Known Adult Returns Produced From a Given Number of Eggs Deposited, 1972-1982.

Year	Escapement	Potential Egg Deposition (millions)	Adult Return
1972	9,270	15.0	98,773
1973	13,120	29.6	24,962
1974	13,150	17.7	52,704
1975	5,640	12.7	15,947
1976	14,700	23.5	113,432
1977	16,070	18.2	
1978	34,150	62.8	
1979	19,700	30.9	
1980	28,670	44.2	
1981	21,140	32.0	
1982	56,080	89.7	

prevailed in 1976, 1977 and 1979. Egg deposition estimates for these years were relatively low (Table 22). Although these data are limited, it does appear reasonable to assume high water during the spawning and incubation period washed eggs from the gravel resulting in low deposition estimates. It was further postulated that a small number of incubating eggs would result in reduced production and a less than average adult return. Table 22 indicates this supposition is not correct.

This table reveals no correlation between egg density as determined by hydraulic sampling and the magnitude of the adult return. Regression analysis of egg density (x) and adult return (y) yields a correlation coefficient of 0.047 or no correlation. Predictions regarding returns of early run Russian River sockeye salmon are apparently subject to factors other than, or in addition to, egg density; i.e. carrying capacity of Upper Russian Lake, predation during freshwater residency, relationship of early run rearing fish to late run rearing fish, marine survival, etc. Until these parameters are identified, there is no value in continuing to determine early-run egg deposition in upper Russian Creek.

Climatological Observations

Climatological data recorded at lower Russian Lake were grouped by 6-day periods to facilitate analysis (Table 23). No correlation was found between air and water temperature and sockeye salmon migration. These temperatures were comparable to prior years' data. Total precipitation from June 13 to September 4 was 107.2 mm (4.2 in). This rainfall is less than that recorded in either 1980 or 1981 and resulted in average flow through Russian River Falls during the 1982 season.

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Table 22. Early Run Russian River Sockeye Salmon Egg Densities in Upper Russian Creek and Known Adult Returns From These Densities, 1972-1981.

Year	Egg Dug	Mean Eggs Per Point	Percent Survival	Density ($Eggs/M^2$)	Adult Return
1972	3,790	75.8	81.1	407.8	98,773
1973	2,967	59.3	93.0	319.6	24,962
1974	8,229	84.0	64.2	455.6	52,704
1975	605	6.2	84.3	33.3	15,947
1976	901	12.7	91.6	61.3	113,432
1977	981	12.6	55.0	67.7	
1978	4,415	48.0	87.6	226.1	
1979					
1980	5,102	58.0	68.6	315.5	
1981	1,862	17.9	59.9	97.3	

Table 23. Climatological and Hydrological Observations by Six Day Periods Recorded at Lower Russian Lake Weir, June 13-October 10, 1982.

Period	Water Temp.* Max °C	Water Temp.* Min °C	Air Temp.* Max °C	Air Temp.* Min °C	Rainfall (mm)**	Russian River Discharge (cfs)	Rondezvous Creek Discharge (cfs)
June 13-18	8.8	8.8	14.4	5.3	0.2	209.2	26.4
June 19-24	8.7	8.3	15.3	5.9	2.2	197.5	28.8
June 25-30	9.6	9.3	18.9	7.0	12.4	224.6	53.6
July 1-6	8.9	8.9	14.7	6.5	5.9	220.0	45.6
July 7-12	10.2	9.8	18.4	8.7	10.4	198.7	46.3
July 13-18	10.5	10.5	17.0	6.9	21.4	198.7	50.5
July 19-24	12.4	12.4	16.3	8.1	15.4	188.9	45.4
July 25-30	13.9	12.8	18.5	9.8	7.4	188.9	54.6
July 31 Aug. 5	13.5	13.1	20.4	6.3		166.6	46.2
Aug. 6-11	14.3	12.9	16.9	7.8	3.8	146.1	33.0
Aug. 12-17	14.3	11.9	18.3	4.3	1.8	127.9	26.1
Aug. 18-23	14.3	12.2	18.5	4.8	0.4	124.7	21.7

Table 23. (cont.) Climatological and Hydrological Observations by Six Day Periods Recorded at Lower Russian Lake Weir, June 13 - October 10, 1982.

Period	Water Temp.* Max °C	Water Temp.* Min °C	Air Temp.* Max °C	Air Temp.* Min °C	Rainfall (mm)**	Russian River Discharge (cfs)	Rondezvous Creek Discharge (cfs)
Aug. 24-29	14.1	12.2	15.9	8.3	8.2	139.9	20.3
Aug. 30 Sept. 4	13.5	11.9	13.5	5.4	18.4	139.9	19.4
Sept. 5-10	12.2	10.7	13.1	5.5	78.2	189.7	24.4
Sept. 11-16	10.5	8.8	14.1	7.1	33.3	190.1	33.1
Sept. 17-22	10.6	9.1	11.5	6.5	26.4	325.9	59.4
Sept. 23-28	8.8	6.7	11.2	-0.2	3.0	270.8	45.7
Sept. 29 Oct. 4	7.8	6.3	7.8	0.9	18.0	205.3	29.9
Oct. 5-10	5.5	4.4	2.2	-2.7	Light Snow	170.3	22.7

* Air and water temperatures for the respective periods are the mean of the daily recordings.

** Rainfall for each period is the cumulative total of the daily recordings.

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